Servicing gas turbines

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Abstract of **GB2177160**

In a method of carrying out maintenance procedure for a gas turbine engine designed to be built or dismantled in the vertical mode, the engine is mounted horizontally within a rolling frame with the front and rear engine mounts, F and R, in registration with and secured to corresponding locations on the rolling frame. Additional load-bearing connections between the engine and the rolling frame are made utilising landings, eg., compressor casing 12, existing on the engine, and then the rear engine mounts are removed. In further steps, an auxiliary frame 26 is mounted on the rolling frame a linear track 27 on the auxiliary frame extending parallel with the engine axis. A runner 29 on the linear track is attached to a section of the engine using an adjustable hoist 30 mounted on the runner, shifting of the runner along the track is effective to withdraw the engine section from the assembly.

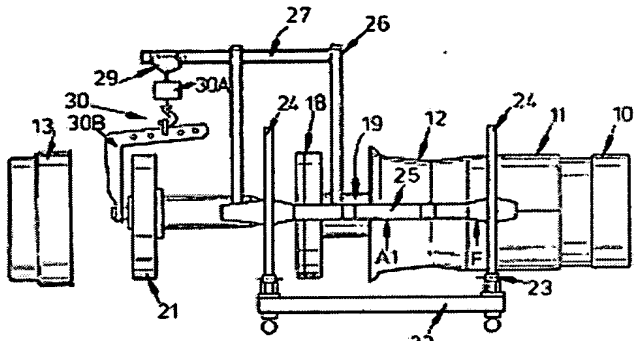

FIG. 8

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(54) Servicing gas turbines

(57) In a method of carrying out maintenance procedure for a gas turbine engine designed to be built or dismantled in the vertical mode, the engine is mounted horizontally within a rolling frame with the front and rear engine mounts, F and R, in registration with and secured to corresponding locations on the rolling frame. Additional load-bearing connections between the engine and the rolling frame are made utilising landings, eg., compressor casing 12, existing on the engine, and then the rear engine mounts are removed. In further steps, an auxiliary frame 26 is mounted on the rolling frame, a linear track 27 on the auxiliary frame extending parallel with the engine axis. A runner 29 on the linear track is attached to a section of the engine using an adjustable hoist 30 mounted on the runner, shifting of the runner along the track is effective to withdrew the engine section from the assembly.

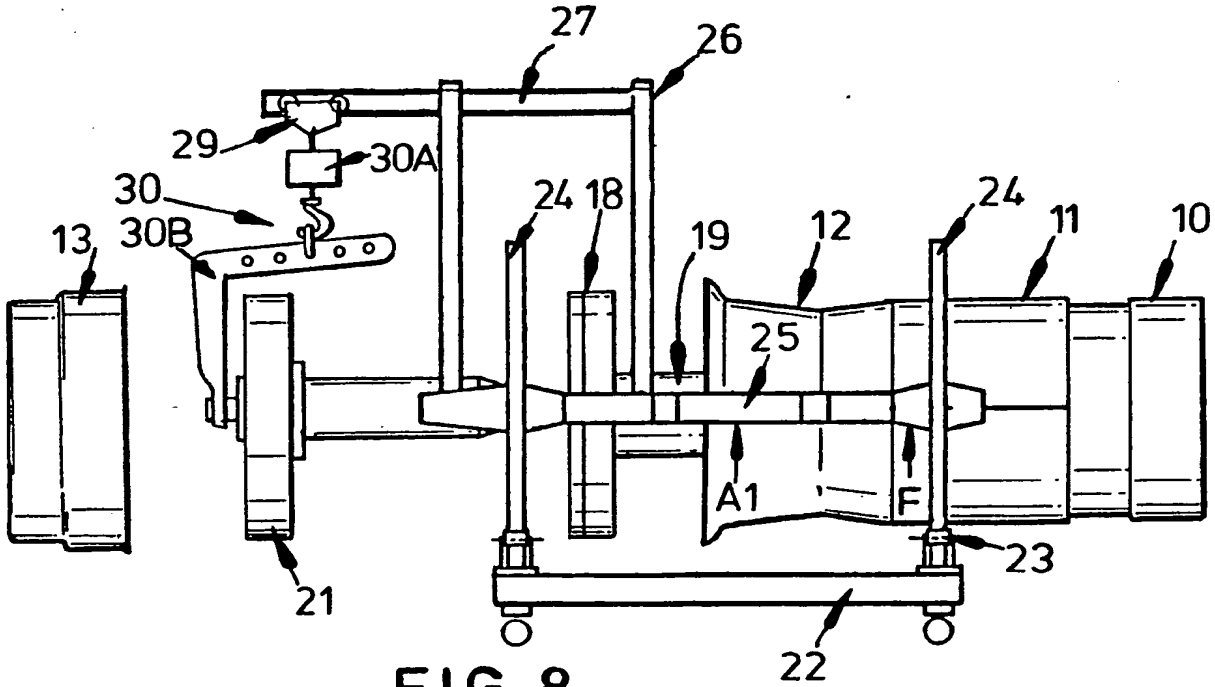

FIG. 8

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

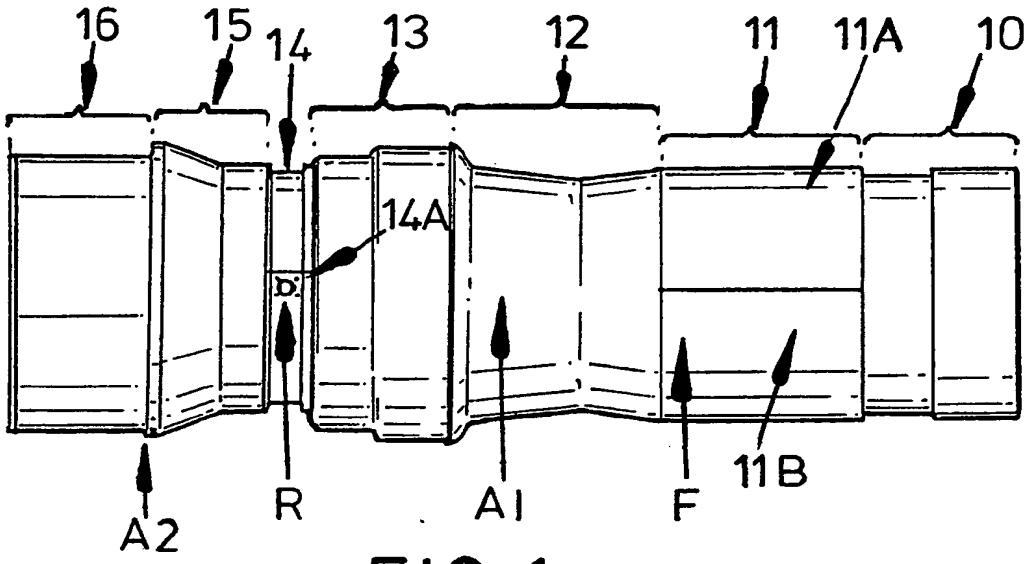


FIG. 1

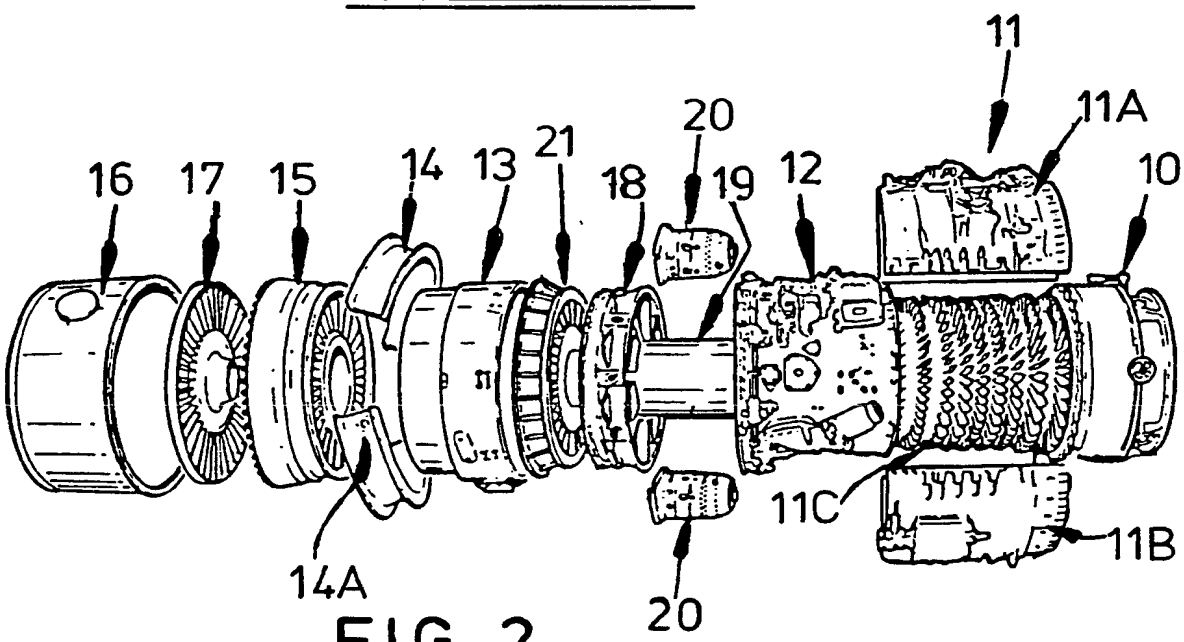


FIG. 2

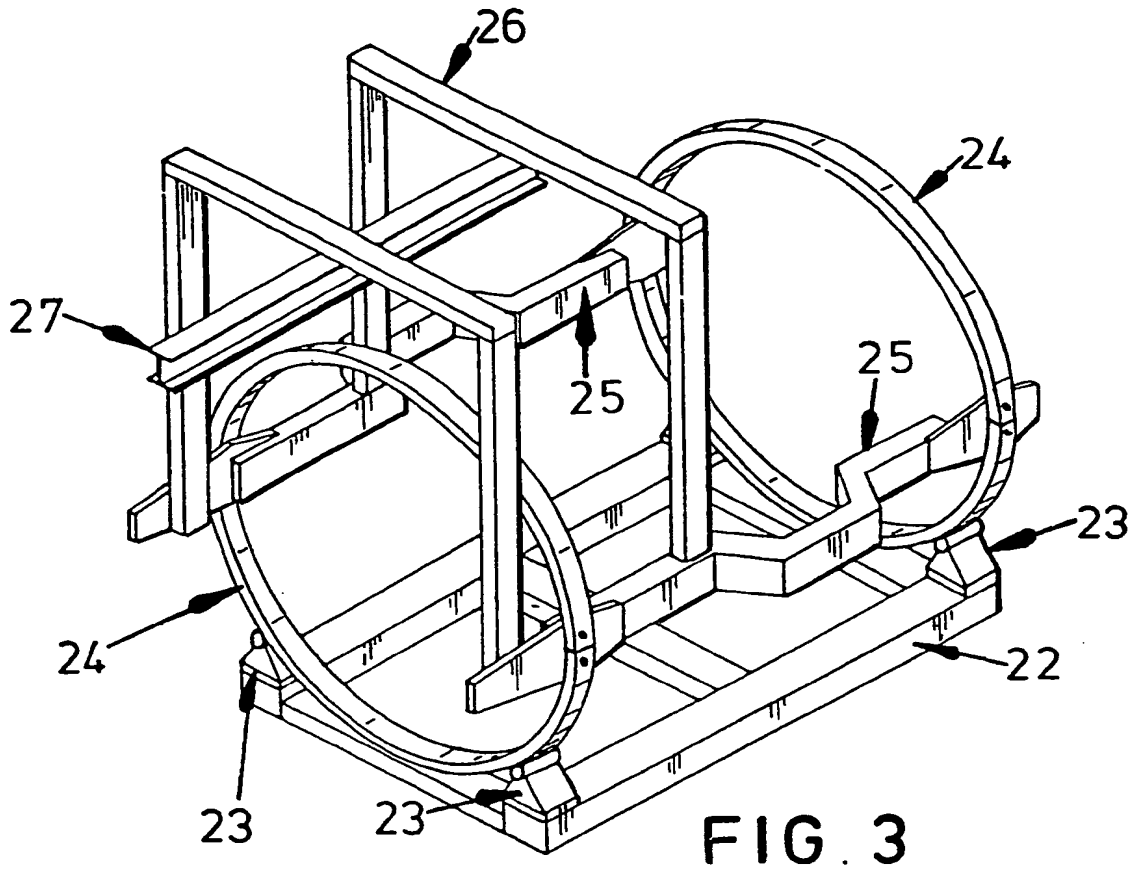


FIG. 3

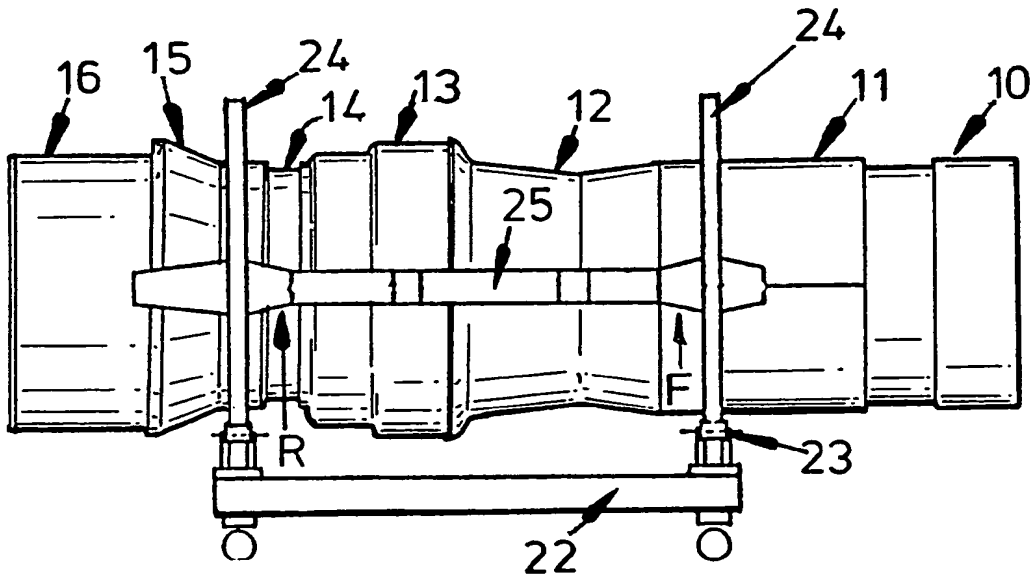


FIG. 4

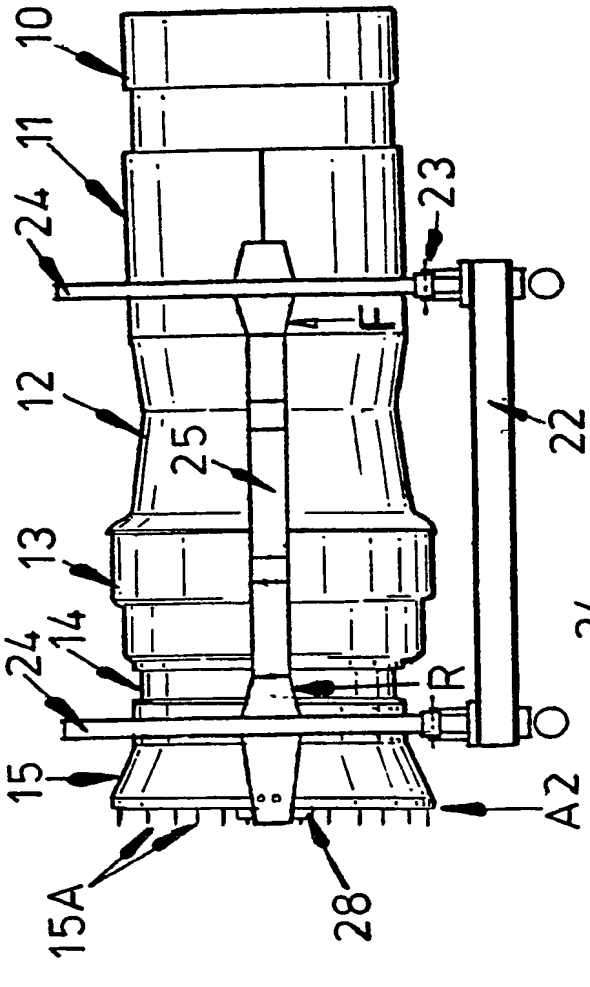


FIG. 5

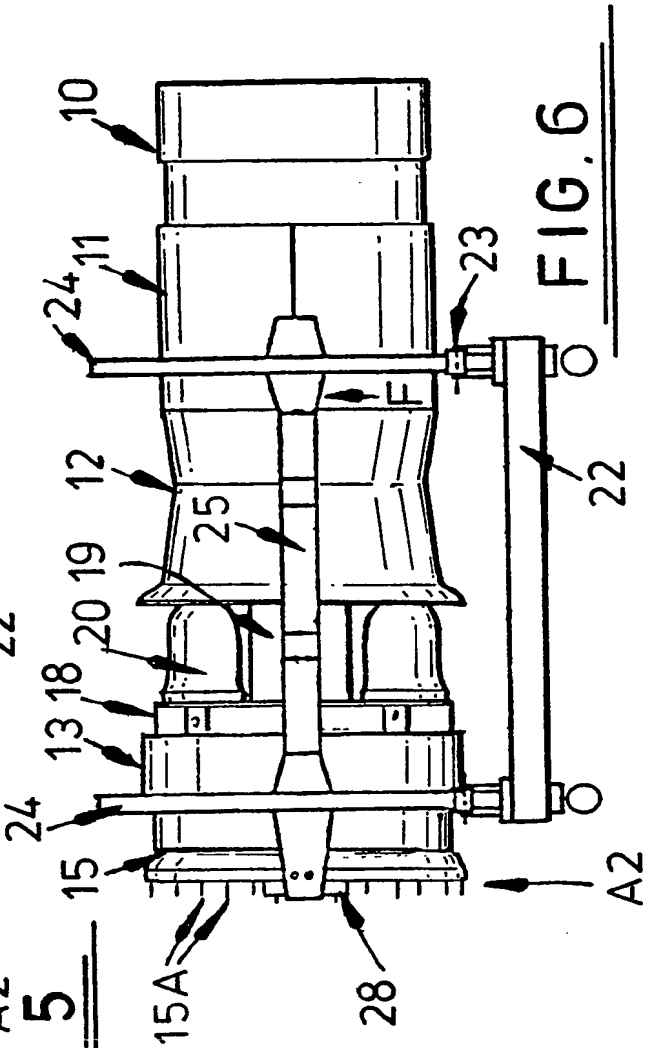


FIG. 6

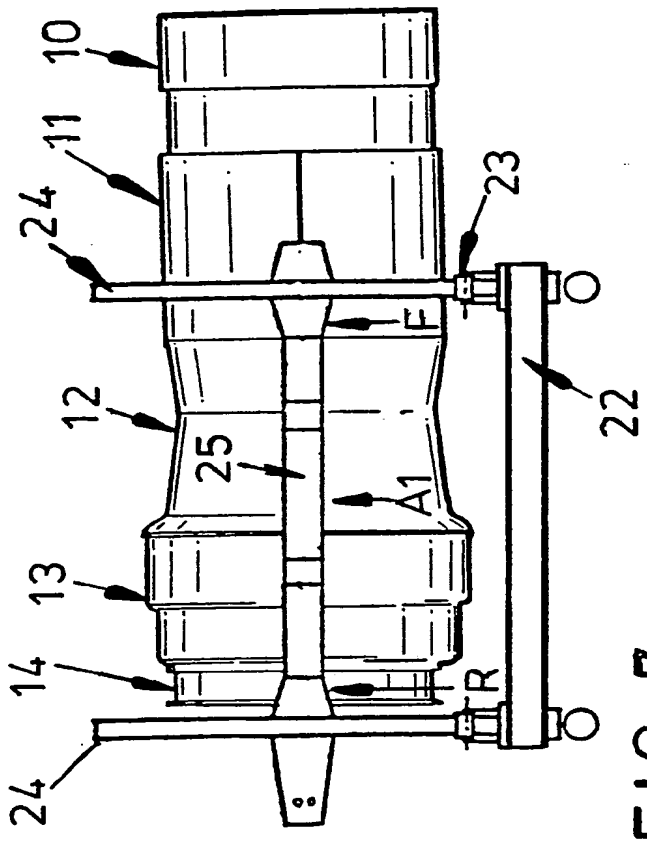
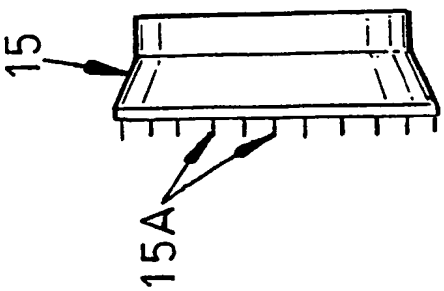


FIG.7



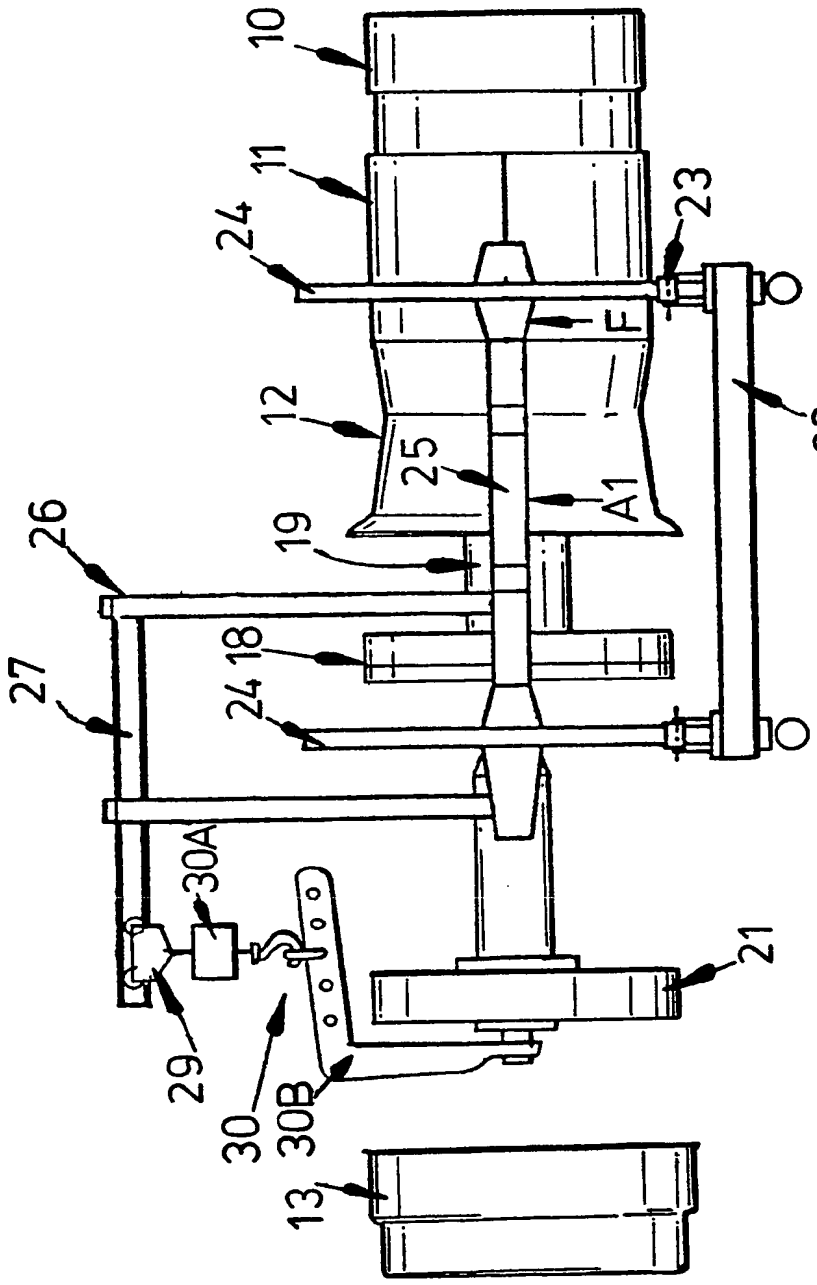


FIG.8

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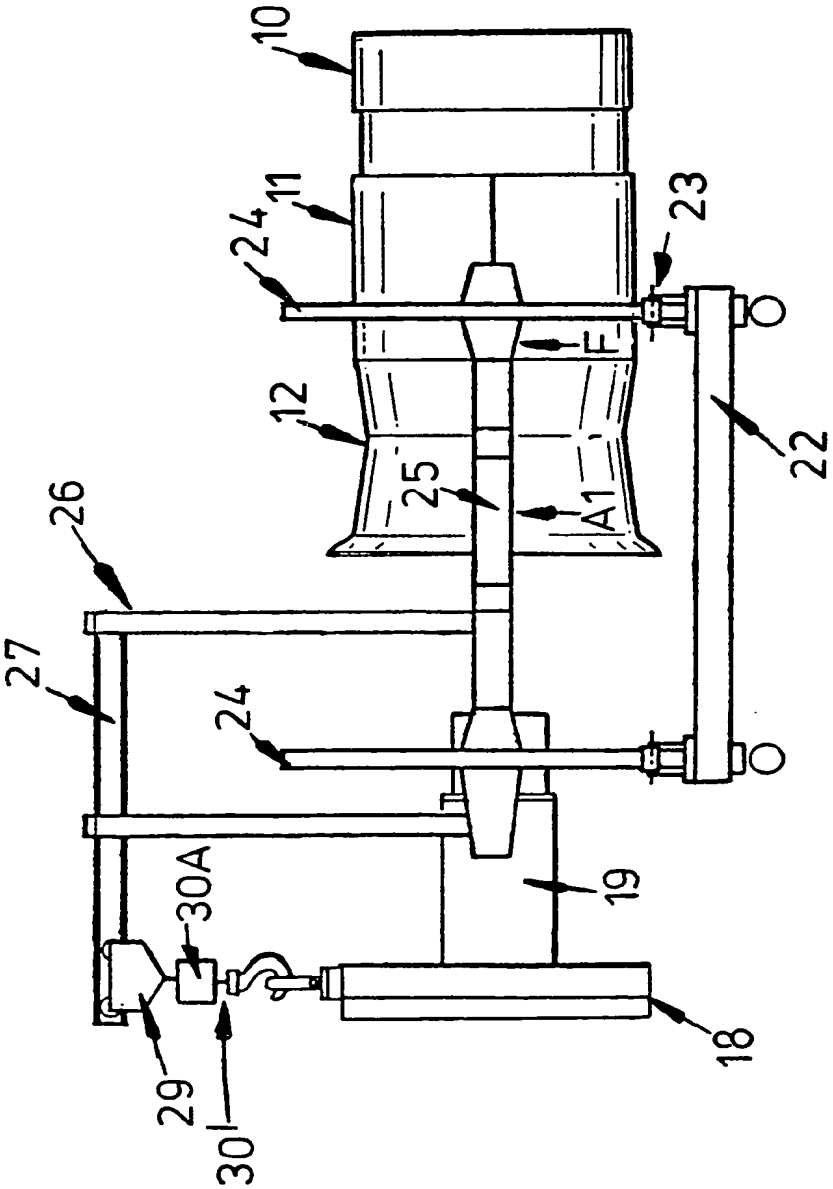

FIG.9

SPECIFICATION

Servicing gas turbines

This invention relates to a method of and apparatus for use in carrying out maintenance procedure for a gas turbine engine designed to be built or dismantled in the vertical mode (hereinafter referred to as an engine "of the type stated").

Such engines are normally operated in the horizontal mode, that is with the principal axis of the engine disposed generally horizontal, the engine being mounted on forward and rear mounts, the latter in the form of trunnion bearings and being attached to one of the casings of the turbine section. Accordingly, full dismantling of the turbine section of the engine is not possible while the trunnion bearings (or rear mounts) are relied upon to support the engine in the horizontal mode; and in at least some engines of the type stated, access to the flame tubes is impossible while the rear mounts are in place.

Another feature of an engine of the type stated is that certain sections of the engine interengage in nested configuration and therefore can not be removed laterally simply after decoupling from adjacent sections. In other words, the engine is of a "non-modular" construction. In the Rolls Royce industrial AVON gas generator, for example, the rear bearing housing which lies on the principal axis of the engine adjacent the flame tubes is removable only by axial withdrawal of the adjacent turbine nozzle front section to which the rear bearing housing is assembled. Similarly, the high and intermediate pressure turbine assembly and nozzle box intermediate casing must be withdrawn axially.

In many field situations, facilities capable of swinging an engine of the type stated into the vertical position are not available. Such facilities would include two hoists, special slings, and a floor to crane hook height of the order of six metres. Without these facilities, maintenance work that can be achieved with the engine supported in the horizontal mode by means of the normal forward and rear engine mounts is limited to external items and the first few stages of the compressor.

According to one aspect of the present invention, there is provided a method of carrying out maintenance procedure for an engine of the type stated, comprising the steps of:—

mounting the engine in a main frame with the front and rear engine mounts in registration with and secured to corresponding locations on said frame; establishing additional load-bearing connections between the engine and the frame utilising landings existing on the engine; and

demounting the said rear engine mounts thereby transferring all of the rear support duty to said additional connections.

The method utilising the said additional connections and allowing demounting of the usual rear engine mounts makes available various options of strip sequence any of which may be selected according to requirements determined by inspection of the engine, all of these strip options being capable of execution with the engine in the horizontal mode.

According to another aspect of the present invention, there is provided a method of carrying out maintenace procedure for an engine of the type stated comprising the steps of:—

mounting the engine horizontally within a main frame;

mounting an auxiliary frame on the main frame with a linear track on the auxiliary frame extending parallel with the engine axis;

interconnecting a runner on said track with a section of the engine using an adjustable suspension means adapted for attachment to said engine section so that the centre of gravity of the latter is substantially vertically below the runner;

adjusting said suspension means to take the weight of said engine section; and

shifting the runner along the track thereby to withdraw said engine section from the engine assembly.

In performing either of the aforementioned aspects of the present invention, it is preferable that the said main frame is a rolling frame having at least two circular tracks each engaging a respective set of rollers to enable the frame to be turned on a horizontal axis coincident with the axes of the circular tracks.

Further, according to the present invention, there is provided apparatus for use in carrying out the method aforesaid, comprising a rolling frame having at least two circular tracks each engaging a respective set of rollers to enable the frame to be turned on a horizontal axis, frame members interconnecting said tracks and providing support means for carrying an engine of the type stated co-axially with the axis of said circular tracks, an auxiliary carrier frame demountably secured to said frame members and comprising a linear track disposed parallel with the axis of the circular tracks, and a runner shiftable on said linear track and adapted for connection thereto of suspension means.

Preferably, each of the said circular tracks comprises mutually separable track sections.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic outline side elevation of an engine of the type stated;

Figure 2 is an exploded view in side elevation of the engine of Fig. 1 to a slightly smaller scale;

Figure 3 is a perspective view of a frame assembly in accordance with the present invention adapted for supporting the engine of Figs. 1 and 2; and

Figures 4 to 9 inclusive show progressively different stages in the dismantling of the engine of Fig. 1 when mounted in the frame assembly of the Fig. 3.

Figs. 1 and 2 serve to identify the main assemblies of the engine of the type stated which, in this example, is a Rolls Royce industrial AVON gas generator. The principal engine sections or assemblies are given in Table 1 together with their respective reference numerals.

Full details of the construction and operation of the AVON engine are documented elsewhere. In the present context, the following features are of interest. The engine is normally operated in the horizontal mode, that is with its principal rotational axis generally horizontal. Mounting of the engine in the horizontal mode is achieved using front and rear mounts which are positioned approximately as indicated by arrows F (front) and R (rear) in Fig. 1. Landings (not shown) associated with the front engine mounts are formed on portions of the compressor bottom casing 11B, and the rear engine mounts are in the form of trunnion supports which are carried on the cooling air manifold front casings 14. A trunnion mount position is indicated by reference numeral 14A. The compressor outlet casing 12 has a number of machine landings thereon of which the cabin air off-take (not shown) is selected for the purpose of establishing an additional load-bearing connection to serve as a temporary engine mount as explained further later in this description. The approximate position of the cabin air off-take is indicated by arrow A1 (additional one) in Fig. 1. A further such landing for an additional load-bearing connection is constituted by the machined rear face of the turbine nozzle box rear section 15, indicated by arrow A2 in Fig. 1.

TABLE 1

ITEM	REFERENCE NO.
Anti-icing manifold and front bearing housing	10
Compressor	11
Compressor top and bottom casing halves	11A, 11B
Compressor blade assembly	11C
Compressor outlet casing	12
Combustion air casing	13
Cooling air manifold front casings	14
Turbine nozzle box-rear section	15
Cooling air manifold rear casing	16
Low pressure turbine wheel	17
Turbine nozzle box-front section	18
Rear bearing housing	19
Flame tubes	20
High pressure/intermediate pressure turbine assembly	21

The AVON engine is of generally non-modular construction in that certain sections of the engine interengage in nested configuration and can not be removed laterally simply after decoupling from adjacent sections. In particular the HP/IP turbine assembly 21 must be withdrawn axially together with its main shaft from engagement with the rear bearing assembly within the rear bearing housing 19. In practice, such withdrawal must be performed with precision in order to avoid damage to the stage interstage seals. Also, the turbine nozzle box front section 18 together with the rear bearing housing 19 must be withdrawn axially away from the compressor outlet casing 12. Normally, where such extensive stripping of this engine is required, the engine must be partially stripped and then lifted into the vertical mode so that the above mentioned major turbine components can be lifted out by means of a hoist.

In Fig. 3 of the drawings, the frame assembly for holding the AVON engine during maintenance procedure consists of a main frame, and an auxiliary frame which is demountably secured to the main frame. More particularly, the main frame comprises a base frame 22 of rectangular configuration and carrying a set of four roller supports 23. The remaining major components of the main frame are constituted by a pair of circular tracks 24 which are mutually interconnected by longitudinally extending bearer members 25. The base frame 22 is preferably provided with castor wheels and/or screw jack means (not shown in Fig. 3), the castor wheels to provide for ease of movement of the frame assembly, and the screw jack means to provide for fine positioning of the main frame.

The circular tracks 24 are of split construction to enable assembly of the main frame around an engine to be serviced.

Demountably secured to the bearers 25, is an auxiliary frame in the form of a gantry assembly 26 incorporating a linear track 27 which extends parallel with the axis through the centre of the circular tracks 24.

In Fig. 4, after preliminary dismantling of exterior engine components such as the intake flare and associated components (not shown) and the exhaust unit (not shown), the main frame above described has been assembled around the engine so that the engine principal axis is coincident with the axes of the circular tracks 24. The engine is secured to the main frame using the normal forward and rear engine mounts as indicated in Fig. 4 by the arrows F and R. In this condition, the engine with the main frame may be shifted to any convenient place for further servicing; and the engine can be turned on its axis by means of the circular tracks 24 and the roller assemblies 23 so that any part on the exterior of the engine may be made readily accessible.

In Fig. 5, the cooling air manifold rear casing 16 has been removed from the engine thereby giving access to the landing constituted by the rear face of the turbine nozzle box rear section 15. The rear face of the section 15 is of annular configuration and carries a circular array of machine screw studs 15A. Additional load/bearing connections are established between the carriers 25 of the main frame and the rear face of the section 15. These additional connections are in the form of radially disposed carrier plates 28 one of which is shown in Fig. 5. The carrier plates 28 are secured to the rear face of section 15 using some of the machine screw studs 15A and to the adjacent ends of the carriers 25 thereby to establish engine load bearing connections at the position A2. Thus, as shown in Fig. 5, the engine is supported by the front and rear mounts and additionally by the carrier plates 28.

In Fig. 6, the connection between the carriers 25 and the rear engine mounts have been removed, and the combustion air casing 13 has been shifted axially to the rear of the engine thereby giving access to the flame tubes 20 and revealing part of the turbine nozzle box front section 18. In this condition, the flame tubes 20 and associated components may be completely serviced and thereafter the combustion air casing 13 slid back into its original position, connections between the carriers 25 and the rear engine mounts re-established, and the engine reassembled. Alternatively, if further deeper servicing is required, with the engine rear mounts refitted, the turbine nozzle box rear section 15 may be removed after removal of the low pressure turbine wheel 17 and the additional carrier plates 28. If still deeper serving of the engine is required, then a second additional set of load/bearing connections is established between the carriers 25 and the existing landings on the compressor outlet casing 12 at position A1 as indicated in Fig. 7. With the load/bearing connections established at both positions F and A1, the normal rear engine mount may be disconnected at position R.

In Fig. 8, with the engine supported by way of the front engine mounts at position F and the additional load/bearing connections at position A1, the rear mounts at position R have been removed together with the cooling air manifold front casings 14 (see Fig. 2) and the combustion air casing 13. To enable further dismantling of the turbine, the main frame is positioned with the carriers 25 disposed horizontally one on either side of the engine principal axis. Thereafter, the auxiliary frame 26 is secured to the main frame (securing means not shown) so that the linear track or carriage beam 27 is parallel with the engine principal axis. The track 27 carries a runner or carriage 29 to which is attached an adjustable suspension means 30. In Fig. 8, the adjustable suspension means 30 comprises a hoist 30A and a cranked lifting arm 30B one extremity of

which is adapted for attachment to the HP/IP turbine assembly 21 while the adjacent leg of the arm 30B is provided with a series of connection points so that the load hook of the hoist 30A can be brought into alignment with the centre of gravity of the turbine assembly 21. Thus, with the suspension means 30 adjusted to take the weight of the assembly 21, the assembly can be withdrawn axially by shifting of the carriage 29 along the track 27 until the assembly 21 complete with its attached main shaft is clear of the other engine components.

In Fig. 9, the final stage of turbine dismantling following Fig. 8 is achieved by axial withdrawal of the turbine nozzle box front section 18 together with the rear bearing housing 19. In this case, the adjustable suspension means 30' consists merely of the hoist 30A, the withdrawal action being effected as already described in relation to the assembly 21.

CLAIMS

1. A method of carrying out maintenance procedure for an engine of the type stated, comprising the steps of mounting the engine in a main frame with the front and rear engine mounts in registration with and secured to corresponding locations on said frame, establishing additional load-bearing connections between the engine and the frame utilising landings existing on the engine, and demounting the said rear engine mounts thereby transferring all of the rear support duty to said additional connections.

2. A method of carrying out maintenance procedure for an engine of the type stated, comprising the steps of the mounting the engine horizontally within a main frame, mounting an auxiliary frame on the main frame with a linear track on the auxiliary frame extending parallel with the engine axis, interconnecting a runner on said track with a section of the engine using an adjustable suspension means adapted for attachment to said engine section so that the centre of gravity of the latter is substantially vertically below the runner, adjusting said suspension means to take the weight of said engine section, and shifting the runner along the track thereby to withdraw said engine section from the engine assembly.

3. A method as claimed in claim 1 or 2, wherein the main frame is a rolling frame having at least two circular tracks each engaging a respective set of rollers to enable the frame to be turned on a horizontal axis coincident with the axes of the circular tracks.

4. Apparatus for use in carrying out the method claimed in claim 1 or 2 or 3, comprising a roller frame having at least two circular tracks each engaging a respective set of rollers to enable the frame to be turned on a horizontal axis, frame members interconnecting said tracks and providing support means for carrying an engine of the type stated co-axially with the axis of said circular tracks, an auxiliary carrier frame demountably secured to said frame members and comprising a linear track disposed parallel with the axis of the circular tracks, and a runner shiftable on said linear track and adapted for connection thereto of suspension means.

5. Apparatus as claimed in claim 4, wherein each of the said circular tracks comprises mutually separable track sections.

6. A method of carrying out maintenance procedure for an engine of the type stated, substantially as hereinbefore described with reference to the accompanying drawings.

7. Apparatus for use in carrying out the method claimed in claim 1 or 2, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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